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AUTHOR	Untiedt, Theodore P.
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ABSTRACT

Despite the many improvements which have been made in the television picture over the last 25 years of commercial broadcasting, improvements in television sound have lagged behind. Both the telephone company and broadcast equipment manufacturers have made great improvements in the field of audio which may be used to improve television sound. However, television receiver manufacturers are hesitant to make changes in the aural portions of the receiver because the extra cost could not be justified to set buyers. However, one of the Network Transmission Committees has drawn up specifications for a system that would combine audio and video. These specifications (the parameters of which are included here) would cause a great improvement in sound. Tests of other systems by the telephone company, by the British Broadcasting Corporation, and by Japan's public broadcasting system also promise great improvement. (JK)

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IMPROVEMENTS IN TELEVISION SOUND

By

Theodore P. Untiedt
V.P. of Eng. & Fac.
KCET-Channel 28
Los Angeles, Calif.

This year commercial television celebrated its twenty-fifth year in television broadcasting, a very great event. The pioneering and development of television, of course, started long before that time.

We have been able to witness many changes with advanced technology that have improved the television signal. Such as:

1. The 3" Image Orthicon Pick-up Tube, which was utilized in the first regular live studio and remote pick-ups, by R.C.A., in cameras such as the T.K. 10 and later used in more stabilized cameras such as the R.C.A. T.K. 11.
2. In 1954, the great advance to color became a reality, utilizing the N.T.S.C. color system, with R.C.A. and N.B.C. doing much of the pioneering and early telecasts to a very small audience capable of receiving it in color.
3. The improved 4 1/2" Image Orthicon Pick-up Tube, which greatly improved picture resolution and grey scale with improved stability.
4. In 1964, came the introduction of the Plumbicon Pick-up Tube, utilized at first in the Phillips color camera, later by many other manufacturers. The Plumbicon gained very wide acceptance by broadcasters as a means to good color and with advanced solid state technology making cameras more stable, with greater sensitivity and simplified set-up.
5. The same changes have taken place in the television film camera chains advancing from the Iconscope, to the vidicon and now virtually all manufacturers are making the Plumbicon tube available as an option. Great advances in television film camera design have improved the process of converting color film optical images to the television signal.

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Another great advancement for the television viewers on the West Coast, especially with a great change in picture quality, came with the introduction of the videotape recorder replacing the kinescope recording process that had been used for time zone delay of programs. The developments that have taken place in this medium are also tremendous, where with certain options color videotaped programs can be interchanged on videotape recorders with virtually no deterioration in picture quality. In recent years, we have also seen the development of the video disc recorders, which have added so much to sporting events, with its instant replay at any speed, plus the great asset it is in post production editing.

The improvements in the audio portion of the television signal have not been so fortunate, though.

In April of this year, the San Francisco branch of the Audio Engineering Society had as a topic of their meeting, "Why Can't Television Sound Be Better"? Various members from the television industry were asked to serve on a panel to discuss the subject. The panel consisted of representatives of receiver manufacturers, broadcast equipment manufacturers, Pacific Telephone and Telegraph, Public Broadcasting System, consulting engineers, and commercial and public television broadcasters. Mr. John Ball represented the Public Broadcasting System, while Gerald Plemmons, K.Q.E.D.-San Francisco, and myself represented public television as broadcasters.

The panel led off by each member (about eighteen of them) giving a short talk on what they thought could be done to improve television sound. Following this was a panel discussion with questions from the audience.

Many interesting things came out of this exchange of information. The most encouraging improvement came from the telephone company representative who stated they had received their first sound diplexer system and had done preliminary checks on the unit. They stated that, although they could not tell us the exact performance of the unit, because of certain reasons, they were quite pleased with the unit and that considerable improvements in frequency response and signal-to-noise could be expected.

Broadcast equipment manufacturers have made some great improvements in the field of audio in such lines as audio amplifiers, limiters, compressors, audio consoles, audio cartridge recorders, reel-to-reel audio tape recorders, equalizers, and etc. Broadcasters are generally quite eager to purchase equipment that will improve the audio signal that they are transmitting.

There was some discussion that came up about the possibilities of increasing the amount of deviation that the television audio signal is utilizing. Increased deviation would give great problems to the many millions of television receivers already in the field, so this was quite quickly decided against because of the compatability problems.

The most discouraging point of the meeting came from the receiver manufacturers who have made great strides in the visual portion of the receiver and advances in color. They are very hesitant to make a change in the aural portions of the receiver, however, they feel that to install larger speakers in the receivers would cost several additional dollars. By the time the consumer purchased a new receiver this would be a cost difficult to justify because of the many programs that are transmitted via telephone company long lines, which has limited frequency response presently to 5 KHZ. Several people asked about the possibility of at least having a jack installed, by the manufacturer, either for an additional speaker or one possibly from the output of the sound detector. It was again brought up that cost wise this was not feasible. The hopeful improvement in long lines audio transmission in the future was pointed out, but this again brought little reaction.

The modern television receiver has so many added features to give a better color picture with simplified operating controls, which people seem to pay for, that it is almost unbelievable that people would not pay additional dollars for a better sound system.

Some improvements are being made in receivers with solid state design with output stages not requiring output transformers. Some receivers use complementary symmetry output stages in many instances, but yet still driving a small 4, 5 or 6 inch oval speaker which are not of the best quality, generally.

As many of you know, A.T.& T. experimented with a sound in sync system called T.I.D.I., which consisted of keying in audio information on the front porch of the horizontal sync pulse. This type of audio signal was looked at as improving several facets: the audio signal following the same physical routing as the video of which many of us have experienced audio delay from time to time under the present system; a small improvement in audio frequency response, extending the response from the normal 5 KHZ to between 6.5 and 7 KHZ; and with some improvement in signal to noise. Some problems were envisioned in this method of transmission, which included a high degree of stability in originating stations sync generator and also in the case of the videotape machine, servo

stability; that the encoding decoding of the audio signal with the video would take place at local T.O.C.s; and sync processing of the video signal by the carrier of which neither broadcasters or the carrier care to do. After several years in design and testing under actual network conditions, that system has been dropped from consideration, I understand.

It is hopeful that in the very near future one of the greatest improvements in sound quality is to come about for long lines television audio transmission. Specifications are now being drawn up by the Network Transmission Committees sub-committee on audio specifications for a network audio transmission system, combining audio with video. This sub-committee consists of Mr. Robert O'Connor (C.B.S.) as chairman, Mr. Henry Ahnemann (A.T.T. long lines), Mr. John Ball (P.B.S.), Mr. Warren Phillips (N.B.C.), Mr. John Serafin (A.B.C.), Mr. Richard Cassidy (N.P.R.), Mr. Tom Keller (W.G.B.H.), and myself.

Specifications for a new system of combining audio with video would be applicable to Time Division Multiplexed (T.D.M.) or Frequency Division Muliiplexed (F.D.M.) techniques. The system specifications being considered would be for a studio-to-studio basis over a 4,000 mile basis including two local loops-one transmit and one receive loop.

Some of the audio target parameters for such a system, with this type of transmission path, should be designed to meet or exceed the following:

Receive level 0 DB + 0.25 DB

Amplitude to frequency response

50-100	HZ to 100	HZ +	.5 to - 1 DB
100	HZ to 7.5	KHZ +	.5 to -.5 DB
7.5	KHZ to 15	HZ +	.5 to - 1 DB

Random noise (peak signal to unweighted noise)

65 DB

Harmonic distortion

50 HZ	to 100 HZ	1.5 %
100 HZ	to 7.5 KHZ	1 %
7.5 HZ	to 15 KHZ	1.25%

These specifications vary considerably from what are presently A.T.& T. objectives.

Receive Level	-32 dBM
Frequency Response	100 Hz -5,000 Hz within 3 dB
Harmonic Distortion	3%
Noise Weighted	-46 dB

The new target objectives could bring the audio transmission standards up to what exceeds the present Bell System Triple A service.

Many of us on the P.B.S. network have experienced audio problems, which depart very much from what the A.T.& T. objectives are. In defense of the telephone company, they did do a tremendous job of connecting the numerous public television stations together as quickly as they did, and are slowly improving the existing system.

The audio system that the telephone company is presently doing tests with, is frequency diplexing with considerations of subcarrier frequencies at 6.6 MHz and 7.5 MHz. Many broadcasters and common carriers have been utilizing various subcarriers on microwave links for several years, and have encountered only minor problems.

As previously stated, consideration would be for either a F.D.M. or T.D.M. system. The British Broadcasting Company has been experimenting with a system of Time Division Multiplexing for several years. In their system the audio frequency signal is sampled at twice horizontal line frequency, to provide frequency response to 14 kHz, and each sample is converted to a 10 digit pulse code modulation signal. These signals are then inserted, two at a time, in the horizontal sync pulse. At each receiving point the digitized pulses of the pulse code modulation signal are extracted from video waveform and decoded. After decoding of the video signal, it must be reprocessed so that a proper standard composite video signal is again available for transmission.

The digitized sound signal occupies 3.8 us. within each 4.7 us. horizontal sync pulse. The signal is symmetrically spaced with respect to the leading and trailing edges of the pulse. A compressor and expander is utilized to form a compander system that ensures a signal level as high as possible, to achieve best signal to noise. The characteristics of such a system are:

Frequency response	± .5 dB 50 Hz to 10 kHz ± .7 dB 30 Hz to 14 kHz
Non-linear distortion for full modulation at 1 kHz	1% 2nd harmonic .07% 3rd harmonic .02% 4th harmonic
Signal to noise ratio (R.M.S. signal to R.M.S. noise)	70 dB

The system the B.B.C. is working with, is presently being distributed by the Pye Corporation in the United States. At least one U.S. manufacturer is working on a T.D.M. system.

Either system shows that great improvements can be possible to improve the audio portion of the television signal. It is hopeful that with the possibilities of better audio long lines transmission that receiver manufacturers will consider this in their new designs. We as broadcasters must also be aware of hopeful audio performance in the home receiver, and plan and budget for equipment that will give the best performance in our productions and transmission.

Television stereo programs simulcast over F.M. have been done by several public television stations, with great interest and response from the general public that has the equipment set-up to participate in these programs. Stereo programs do present several problems in production, because of additional planning, technical equipment required, engineering set-up time, camera angles, post production and etc. But certain special programs give very rewarding results and response from viewers. The day of the videocassettes and pre-recorded television programs is here, and soon, I am sure, television stereo programs will be available to them. The machines already have two channel capacity for record and playback. It will be a terrible dis-service to the general viewing public, if the only way they can see and enjoy programs of the television stereo medium, is by the investment of a videocassette unit and renting or purchasing pre-recorded programs.

Compatible television stereo transmission is not a new system. The N.H.K's Tokoyo and Osaka television stations demonstrated this at Expo '70. They are also presently using the two channel capability for multi-language programs such as: news programs, whereby the main channel is used for the Japanese language and the alternate channel is used for the English language. N.H.K. laboratories have run very extensive tests to determine which system would give the best performance with minimum interference to existing television receivers, so that compatability could be achieved. Typical values of the overall characteristics, for their system, as published in an E.B.U. Review, December 1970 are:

TYPICAL VALUES OF OVERALL CHARACTERISTICS

CHANNEL	AUDIO FREQUENCY RANGE	DISTORTION (%) 1 kHz	DISTORTION (%) 7 kHz	SIGNAL-TO-NOISE (WEIGHTED) (dB) RF INPUT 70 dB	SIGNAL-TO-NOISE (WEIGHTED) (dB) RF INPUT 60 dB
MAIN	50 Hz to 15000 Hz	0.4	0.4	60	58
SUB	50 Hz to 12000 Hz	1.6	4.5	56	52

CHANNEL	SIGNAL-TO-BUZZ (dB) INTER-CARRIER SOUND	SIGNAL-TO-BUZZ (dB) SPLIT SOUND	CROSSTALK (dB) (COLOURED NOISE) SUB MAIN	CROSSTALK (dB) (COLOURED NOISE) MAIN SUB	STEREOPHONIC SEPARATION
MAIN	56	59	-58	-	0.1 to 1 kHz) 5 to 10 kHz) >20 dB
SUB	51	56	-	-51	1 to 5 kHz >30 dB

Several countries are now considering stereo programs and also which type of programs are best suited for this type of broadcasting, as well as how they are best produced. I understand two of the commercial networks will be doing some television stereo programming this season. It is extremely necessary, by my judgment and several associates, that the testing of compatible television stereo sound transmission begin as soon as possible.

One of my favorite letters received at KCET is from a gentleman, who after purchasing a television receiver with a U.H.F. tuner, now uses his converter to tune in Channel 28 audio to his F.M. tuner to achieve better audio. Another favorite of mine is from a student majoring in Communications, who during one of the stereo simulcast programs, did not have a stereo F.M. tuner in his house, but did have one in his car. He extended his leads from his car speakers, to speakers in the house, so that he could enjoy the program.

I believe that all of this does show that improvements are coming about in television sound, and the interest is there, but a lot of work and public relations with many people will be needed to make it all happen.